Claims

Sub A1

1. A transducer element of a magnetic material for a torque or force sensor having at least one closed loop of magnetisation established within the material, the transducer element emanating a magnetic field that is a function of torque or force over a range of torque or force values,

characterised by

said emanated magnetic field has a non-zero value at zero torque or force.

2. A method of forming a transducer element which as claimed in Claim 1 characterised in that the element is subject to a predetermined torque or force while establishing the closed loop of magnetisation therein or at least one of the closed loops of magnetisation therein.

3. A transducer element as claimed in Claim 1 or a method as claimed in Claim 2 in which the transducer element is of the annular ring kind attachable to a shaft, is of magnetoelastic material and is circumferentially magnetised.

4. A transducer element as claimed in Claim 1 or a method as claimed in Claim 2 in which the transducer element is of magnetoelastic material and is a circumferentially magnetised, integral portion of a shaft.

5. A transducer element as claimed in Claim 1 or a method as claimed in Claim 2 in which said element is annular about an axis and is longitudinally magnetised in the axial direction.

6. A transducer element or a method as claimed in Claim

5 in which the element is an integral portion of a shaft.

7. A transducer element as claimed in Claim 1 or a method as claimed in Claim 2 in which the element has a surface extending radially of an axis, a first annular region of magnetisation disposed about said axis and extending to said surface, and a second annular region of magnetisation disposed about said axis outwardly of said first region and extending to said surface.

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8. A transducer element or a method as claimed in Claim 7 in which the first and second regions of magnetisation are each longitudinally magnetised in the direction of said axis and magnetised with opposite polarity.

9. A transducer element or a method as claimed in Claim 7 in which the first and second regions of magnetisation are each circumferentially magnetised to form a closed loop of magnetisation at said surface, said first and second regions being circumferentially magnetised with opposite polarity.

10. A transducer element or a method as claimed in Claim 7 or 8 in which said transducer element is of plate-like or disc-like form.

11. A method of forming a transducer element in a portion of a shaft subjectable to torque about a predetermined axis, in which a predetermined torque about said axis is established in a portion of the shaft and said portion is given a circumferential or longitudinal magnetisation while subject to the predetermined torque.

12. A method as claimed in Claim 11 in which another or the same predetermined torque is established in another

portion of said shaft and said other portion is given a circumferential or longitudinal magnetisation while subject to the other or the same predetermined torque to provide a further transducer element.

13. A method as claimed in Claim 12 in which a selection is made for the direction of circumferential or longitudinal magnetisation and the direction of the associated predetermined torque for each of the shaft portions to provide two transducer elements having different response characteristics of magnetic field output as a function of torque.

14. A shaft assembly having two axially-displaced transducer elements subject to torque applied about an axis of the shaft, each transducer element having a longitudinal or circumferential magnetisation about said axis of the shaft, wherein each transducer element provides a magnetic field output versus torque response that has a non-zero value at zero torque.

15. A shaft assembly as claimed in Claim 14 in which each transducer element has a zero magnetic field output at a respective predetermined torque.

16. A shaft assembly as claimed in Claim 15 in which each transducer element comprises an integral portion of the shaft.

17. A shaft assembly as claimed in Claim 16 in which each transducer element comprises a ring secured to the shaft.

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18. A torque sensor system for a shaft or the like subject to torque about a predetermined axis comprising a transducer element as claimed in Claim 1, 3 or any one of

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Claims 7 to 10, and a magnetic field sensor arrangement for detecting the torque-dependent field emanated by the transducer element.

19. A torque sensor system for a shaft subject to torque about a predetermined axis comprising a transducer element as claimed in Claim 1, 4 or 6, and whose shaft is the aforesaid shaft, and a magnetic field sensor arrangement for detecting the torque-dependent field emanated by the transducer element.

20. A torque sensor system comprising a shaft assembly as claimed in any one of Claims 14 to 17 and a respective magnetic field sensor arrangement responsive to the magnetic field emanated by each transducer element to provide a torque-dependent output signal, and means for combining the torque-dependent signals to provide an output signal therefrom.

21. A torque sensor system comprising a shaft assembly as claimed in any one of Claims 14 to 17 and a respective magnetic field sensor arrangement responsive to the magnetic field emanated by each transducer element to provide a torque-dependent output signal, and signal processing means which comprises a first channel responsive to at least one of the torque-dependent signals, said first channel comprising an output means having a controllable gain for producing an output signal representing a measure of torque, and which also comprises a second channel comprising means for combining the two torque-dependent output signals to provide a reference signal and means response to said reference signal to apply a control signal

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to said output means to control the gain thereof.

22. A torque sensor system as claimed in Claim 21 in which said first channel is operable to provide an output signal by combining the torque-dependent output signals relating to the two transducer elements.

add B1 add C5